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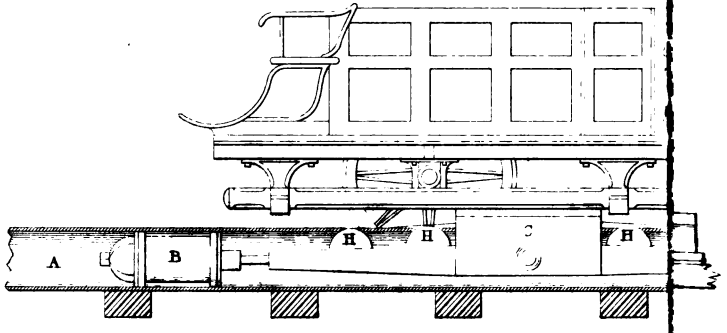
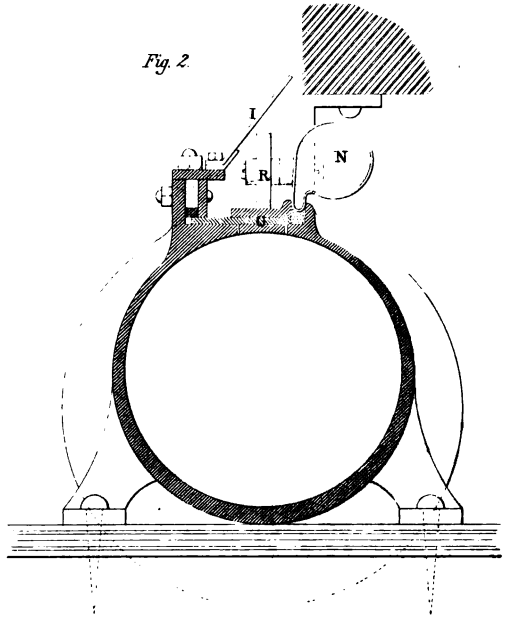


Fig. 2.



A TREATISE

ON THE

ADAPTATION

OF

ATMOSPHERIC PRESSURE

TO THE PURPOSES OF

LOCOMOTION ON RAILWAYS.

WITH TWO PLATES.

BY J. D'A. SAMUDA.

LONDON:
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A TREATISE

ON THE

ADAPTATION OF ATMOSPHERIC PRESSURE TO THE PURPOSES OF LOCOMOTION.

We last year published a pamphlet containing some remarks and calculations on the Atmospheric Railway; on the comparative expense of employing this system and locomotive power, and the general results to be anticipated from its introduction.

That work was published a few weeks after we had commenced working by atmospheric traction on a portion of the Birmingham, Bristol, and Thames Junction Railway; and the principal object sought was to give publicity to the results of these experiments.

From the 11th June, 1840, when we first called public attention to this system, we have regularly continued working it, never less than two days every week, up to the present time; and the experience obtained by actual workings during several months has established the solidity of the system. As a

detail of these results cannot fail to be interesting to the public, we have been induced to publish this edition, for the purpose of giving an account of our operations, which will show the steady and gradual improvements which have been developed; we shall also review such parts of the railway system as are affected by the now established principle of atmospheric traction.

In order to render this pamphlet complete in itself, without reference to the previous edition, and for the information of those who have not seen the system in operation, we have thought it necessary to annex a full description of the nature and action of the invention.

Description of Clegg and Samuda's Atmospheric Railway.

On this system of working railways the moving power is communicated to the train by means of a continuous pipe or main A, laid between the rails, and divided by separating valves into suitable and convenient lengths for exhaustion; a partial vacuum is formed in this pipe either by steam engines and air-pumps fixed at intervals along the road, or by water power, if the nature of the country be such as to afford it. These valves are opened by the train as it advances, without stoppage or reduction of speed. A piston B, which is made to fit air-tight

by means of a leather packing, is introduced into the main pipe* and connected to the leading carriage of each train by an iron plate C, which travels through a lateral opening the whole length of the pipe. This lateral opening is covered by a valve G, extending the whole length, formed of a strip of leather riveted between iron plates; the top plates are wider than the groove, and serve to prevent the external air forcing the leather into the pipe when the vacuum is formed; the lower plates fit the groove when the valve is shut, and making up the circle of the pipe, prevent the air passing the piston; as shown in Plate I. figs. 2, 3, and 4. One edge of this valve is securely held down by iron bars *a a*, fastened by screw bolts *b b* to a longitudinal rib *c*, cast on the pipe on one side of the lateral opening, and the leather between the plates and the bar being flexible, forms a hinge as in a common pump valve; the other edge of the valve falls on the surface of the pipe on the opposite side of the opening, thus forming one side of a trough F, as shown in Plate, figs. 2, 3, 4. This trough is filled with a composition of bees'-wax and tallow, which substance is solid at the temperature of the atmosphere, and becomes

* When the first division or section is exhausted, the separating valve is opened, and the front of the piston being thus exposed to the exhausted portion of the pipe, the atmospheric air pressing on the back of it propels it forward in the pipe, and with it the train to which it is attached.

fluid when heated a few degrees above it. This composition adheres to the edge of the valve, which forms one side of the trough, and to that part of the pipe which forms the other, and produces perfect contact between them; but as the piston advances, the valve G must be raised to allow the connecting plate C to pass, and this is effected by four wheels H H H H fixed to the piston-rod behind the piston, and the aperture thus formed serves also for the free admission of air to press on the back of the piston: by this operation of raising the valve out of the trough, the composition between it and the pipe is broken, and the air-tight contact must be reproduced. To effect this, another steel wheel R is attached to the carriage, regulated by a spring which serves to insure the perfect closing of the valve by running over the top plates immediately after the arm has passed, and a copper tube or heater N, about 5 feet long, filled with burning charcoal, is also fixed to the under side of the carriage, and passes over and re-melts the surface of the composition which has been broken by lifting the valve, and which upon cooling becomes solid, hermetically sealing the valve as before. Thus each train in passing leaves the pipe in a fit state to receive the next train. A protecting cover, I, formed of thin plates of iron about 5 feet long, hinged with leather, is placed over the valve, and serves to preserve it from snow or rain; the end of each plate underlaps

the next in the direction of the piston's motion, thus insuring the lifting of each in succession, which is effected by the wheels D fixed under the carriage.

The separating valves are shown in the annexed diagram.

Fig. 1.



Fig. 2.

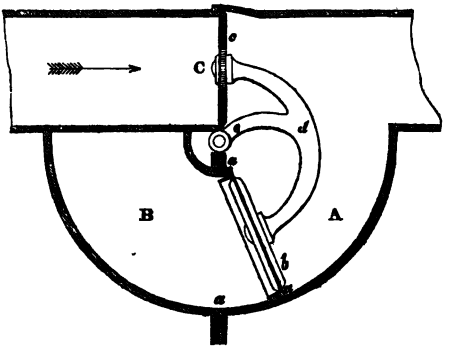


Fig. 1 is the *exit* separating valve, or that, at the end of the section nearest to its steam engine; this valve is opened by the compression of air caused by the piston after it has passed the branch which communicates with the air-pump.

Fig. 2 is the equilibrium or *entrance* separating valve. The arrow denotes the direction in which the trains advance. The pipe is exhausted on the side of the valve lettered C, and is only prolonged on the other side to allow the piston to enter the pipe before the valve is opened. Attached to one side of the main is a semicircular box B A, divided into two compartments by a partition, of which

a a a is a sectional view, and through which is a circular opening: in the top of the box are two small square holes, one on each side of the partition, furnished with a box slide, by which either or both of them may be covered at pleasure; within the box B A are two valves, *b* and *c*, (of which *b* is the greater,) connected by an arm *d d* to each other, and to a vertical axis *e*, on which they can swing horizontally for about 100 degrees. When the pipe is to be exhausted, the valves are placed by hand or otherwise, in the position represented in the Plate; *b* filling the opening in the partition, *c* closing the main. The box slide also covers the hole on the side B of the partition, leaving the other hole open as the exhaustion proceeds; C and B are in vacuum; A and D open to the air. There is then the same pressure on each square inch of *b* and *c*; but *b* being larger than *c*, both remain close, for the total pressure on *b* preponderating, will keep *c* against its seat, as will be plain on looking at the Plate. But the train, on approaching, moves the slide box so as to cover both holes, and a passage is formed through which the air in the partition A, rushes into the main C, so that A and B are both in vacuo, and the pressure being removed from *b*, that on *c forces* it back and allows the piston to pass. The valve, or rather, piston *b*, is a cup leather, riveted between iron plates, and shuts *into* the opening in the partition: *c* is a flat leather valve, and shuts *against* a facing in the main.

The main pipe is put together with deep socket joints, in each of which an annular space is left about the middle of the packing, and filled with a semi-fluid; thus any possible leakage of air into the pipe is prevented.

When it is necessary to stop or retard a train, in addition to the use of a common break, a valve in the travelling piston is opened by the conductor, by which means the external air is admitted into the exhausted portion of the pipe, and the propelling power destroyed.

In localities where a sufficient quantity and fall of water can be obtained, the atmospheric system can be worked without the assistance of *any machinery whatever:* by constructing a tank or tanks (of a total capacity double that of the section of pipe they have to exhaust), filling them with water, and allowing it to run out through a descending perpendicular pipe about 32 feet long (which it will do by its gravity alone), the whole of the air contained in the pipe will expand itself into the tanks, and by the time they are half emptied of water half a vacuum will be formed in the pipes, as the air will be expanded into twice its bulk, and the other half will run out while the travelling piston and train are advancing, thus increasing the space in the tanks as that in the pipes is diminishing by the approach of the piston, and by this means maintaining the same degree of vacuum during the whole time the train is passing, whatever be its speed.

Workings of the Atmospheric Railway on the Birmingham, Bristol, and Thames Junction Railway.

The system is in operation on part of the above line between the Great Western Railway and the Uxbridge Road, on an incline, part 1 in 120, and part 1 in 115.

The vacuum-pipe is half a mile long, and 9 inches internal diameter.

The exhausting-pump is 37½ inches diameter, and 22½ inches stroke, worked by a steam engine of 16 horses' power.

For the purpose of experiment a series of posts were fixed along the half mile every two chains, and a barometric gauge was attached at each end of the pipe, for the purpose of ascertaining the degree to which the pipe was exhausted; a vacuum equal to a column of mercury 18 inches high was obtained in about one minute, and both gauges indicated the same extent of vacuum at the same instant.

The following Table shows a fair average of the results obtained during six months.

	Number of Passengers.	Total load.	Maximum speed in miles per hour.	Vacuum in inches of Mercury.
		tons. cwt.		
June 11, 1840	23	8 0	22½	18
	23	8 0	22½	16
	15	7 10	20	19
	21	7 18	22½	19
	44	9 10	22½	20
	58	10 7	22½	19
	57	10 6	18	19
	25	5 9	30	18¼
	75	11 10	22½	17
	24	8 2	22½	15
	13	4 12	30	16
	9	7 2	22½	16½
June 29, 1840	28	8 2	30	
	28	5 13	30	
	28	5 13	36	
July 24, 1840	21	7 18	30	22
	15	4 15	30	22
	8	4 6	30	23
	15	5 0	30	21½
Aug. 8, 1840	16	5 1	30	21
	18 & ballast	13 10	18	20½
	18	5 4	30	20½
Aug. 10, 1840	15	5 0	30	20
	17 & ballast	13 10	20	22
	10	4 13	30	22
Aug. 11, 1840	28	5 17	30	20½
	25	5 13	30	20
	14	5 0	30	20
Sept. 24, 1840	23	5 10	36	
Nov. 6, 1840	17	5 3	36	21
	16	5 0	45	23½
Dec. 9, 1840	11	4 14	45	23
Dec. 15, 1840	15	5 0	36	22½
Jan. 6, 1841	10	4 13	36	22½
Feb. 19, 1841	8	4 11	45	23½

By following out these results, it will be found that a main pipe of 18 inches diameter will be sufficiently large for a traffic of 5000 tons per day,

viz., 2500 tons in each direction, supposing the gradients of the road to average 1 in 100.

Note.—A main pipe, 18 inches diameter, will contain a piston of 254 inches area: the usual pressure on this piston, produced by exhausting the pipe, should be 8 lbs. per square inch (as this is the most economical degree of vacuum to work at, and a large margin is left for obtaining higher vacuums to draw trains heavier than usual on emergencies)—a tractive force of 2032 pounds is thus obtained, which will draw a train weighing 45 tons, at 30 miles per hour, up an incline rising 1 in 100. Two and a half miles of this pipe will contain 23,324 cubic feet of air, $\frac{4}{9}$ths of which, or 12,439 cubic feet, must be pumped out to effect a vacuum equal to 8 lbs. per square inch; the air-pump for this purpose should be 5 feet 7 inches diameter, or 24·7 feet area, and its piston should move through 220 feet per minute, thus discharging at the rate of $24{\cdot}7 \times 220 = 5434$ cubic feet per minute at first, and at the rate of 2536 cubic feet per minute when the vacuum has advanced to 16 inches mercury, or 8 lbs. per square inch, the mean quantity discharged being thus 3985 feet per minute: therefore $\frac{12439}{3985} = 3{\cdot}1$ minutes, the time required to exhaust the pipe; and as the area of the pump-piston is 14 times as great as that in the pipe, so the velocity of the latter will be 14 times as great as that of the former, or 220 feet per minute $\times 14 = 3080$ feet per minute, or 35 miles per hour: but in consequence of the imperfect action of an air-pump, slight leakages, &c., this velocity will be reduced to 30 miles per hour, and the time requisite to make the vacuum increased to 4 minutes: the train will thus move over the $2\frac{1}{2}$ miles section in 5 minutes, and it can be prepared for the next train in 4 minutes more, together 9 minutes; 15 minutes is therefore ample time to allow between each train, and supposing the working day to consist of 14 hours, 56 trains can be started in each direction, or 2520 tons, making a total of 5000 tons per day. The fixed engine to perform this duty will be 110 horses' power, equivalent to 22 horses' power per mile in each direction.

By reference to the dates of this Table it will be seen that the workings of the system are equally perfect during all seasons; through the height of summer, and in the severest winter that we have known for many years: in no single instance during the whole time has any derangement of the machinery taken place, to prevent, or even to delay for one minute, the starting of the trains. The main pipe and valve have considerably improved by working; the composition for sealing the valve has become so much more firmly bedded in its place, that while in June last we were only able to obtain a vacuum equal to a column of mercury 19 to 20 inches high, we now obtain from 22 to 24 inches, and occasionally 25. The speed, originally from 20 to 30 miles per hour, now ranges from 30 to 45. The whole attendance the valve and main received during this period was that of a single labourer for about one hour every week: the composition now in the valve-groove has never been changed; and 56 lbs. weight only has been added to supply the waste: the cost of this composition, which consists of wax and tallow, is 1*s.* per lb.

We have now procured data from which the economy and advantage of this system can be arrived at with certainty.

It is true that we have heard many objections made; and as these objections, if tenable, would involve the principle of the invention, we cannot do

better than notice and comment on them here. We have been told, 1st. That our experiments do not prove the applicability of the system to an extended line of road.

2nd. That the number of stationary steam engines and establishments required on this system would be an objection, in point of expense, and liability to accident.

3rd. That an accident occurring at one of these stations, or any where along the pipes, would interrupt the traffic on the whole line; and so strenuously has this objection been urged, that we have heard it asserted that a hole, the size of a pin's head, in the sealing composition, would prevent the action of the invention, and thus the traffic might be stopped for a whole day while making fruitless search to discover it.

In answer to the first objection we would say, in every case where a train has been started the pipe has first been exhausted to 18 inches of mercury or upwards: the time of performing this operation is about one minute, and from the barometric gauges fixed at both ends of the pipe the vacuum is ascertained to be formed to an equal extent throughout the whole length without any appreciable difference of time. The pipe laid down is 9 inches diameter, and half a mile long, and a pressure equal to a column of mercury 18 inches high is obtained in one minute by an air-pump 37½ inches diameter, moving through 165 feet per minute.

Now it is obvious that if the transverse section of the pipe be increased to any extent, and the area of the air-pump *proportionately* increased, the result will remain unaltered,—*i. e.* half a mile of pipe will be exhausted in one minute; and supposing the air-pump has to exhaust 3 miles, it will perform the operation in 6 minutes: it is also obvious that if the area of the air-pump be increased in a greater proportion than that of the pipe, the exhaustion will be performed more rapidly, or *vice versâ*. These results are matters of absolute certainty, as convincingly clear, as that the power of a steam engine must be regulated by the area of the piston on which the steam acts. No person of scientific attainments will for one moment doubt, that if a steam engine were made with a cylinder twice the area of the *largest* cylinder ever set to work, the power obtained would be in proportion to the increased area: and so with the air-pumps before alluded to; the excess of work is immediately arrived at that an air-pump 6 feet 3 inches diameter will perform over another of 3 feet 1½ inch diameter, the speed of the pistons being the same in both instances. So plain and self-evident is this result, that we believe the most sceptical will admit it to be correct; and this being granted, the applicability of the system to a line of any length must follow; for whatever the length of railroad be, whether 3, or 30, or 300 miles, no different effects have to be produced. The working a road 30 miles long would

be the same thing as working 10 roads each 3 miles long. Every 3 miles an engine and air-pump is fixed, which exhausts its own portion of pipe before the train arrives; thus, as the train advances, it receives power from each succeeding engine in turn, (and without any stoppage, unless required, until it arrives at its final destination,) and the air-pumps continuing to work, after the train has passed, on the section they act upon, re-exhaust it in readiness for the next.

The second objection, as to the complexity and outlay attendant on a number of fixed engines, may perhaps be better answered by taking a review of the number and expense of these engines and the duty they are required to perform. On a line 30 miles long, supposing the average distance between the engines to be 3 miles, there would be 10 engines and air-pumps with their engine-houses; and if the railroad were appointed for transporting 5000 tons per day over the whole distance, (considerably more than double the amount carried daily on any railroad in England,) the expense of one of these stationary engine establishments would cost complete £4200, which, multiplied by 10, will give £42,000—total cost on the whole line. But it is a fact which probably must have escaped the notice of those urging this expense as a drawback to the atmospheric system, if they were ever acquainted with it, that to perform a traffic of only 1700 tons per day, upwards of one locomotive engine per mile is ne-

cessary; and as each locomotive costs £1500, the total capital required for locomotive power on a railroad 30 miles in length would be £45,000; in first cost, therefore, there would be a saving of £3000 in favour of the stationary power;* but this is far from being the most important saving. Every mill-owner in Lancashire and Yorkshire, and any person connected with mining operations, will readily admit that his outlay being once incurred for a steam engine to drive his machinery or drain his mine, and his engine being once fixed on *terra firma*, its deterioration, uncertainty of action, or annual expense of maintenance, is not a source of annoyance or anxiety to him. Five per cent. per annum on the cost will more than cover all repairs necessary to be performed to it, and all oil, hemp, and tallow used in working it. It is the exception, and not the rule, if a stationary engine once fixed meet with a derangement to render a stoppage necessary.

The annual expenses will be for repairs at 5 per cent. on £42,000	£2100
For coal for these engines (when transporting 2000 tons per day), 6420 tons per year, at 20*s.* per ton . .	6420
Wages to engine-men and stokers	1800
	£10,320

* This saving is in engines *only*, but it should be recollected that there are many other items, and by reference to the comparative expense of the two systems (page 28), it will be seen

The Liverpool and Manchester Railway is 30 miles long, and is the only railway that transports as much as 1700 tons per day over its whole distance; and the annual expense of its locomotive department, including coke, is about £50,000 a year.

Need we make any further comment, when the annual expense of power for the atmospheric system is £10,320, and for performing the same traffic on the locomotive system upwards of £50,000 is found necessary? Great as the pecuniary advantages have been shown to be, we must not forget to correct the third objection; viz., the erroneous opinion that the system is faulty because an accident occurring at one of these stations would interrupt the traffic on the whole line. *Primâ facie*, this argument is correct, but we have already shown how small the chance of accident is to a stationary steam engine; hundreds are employed day and night without interruption, draining mines; if any derangement in their action were to take place, these valuable properties would be overflowed, and it would require no difficulty to point out many establishments where engines have been in action for years together.* But to make assurance doubly

that the total outlay on the locomotive system is £37,600 per mile, and on the atmospheric £15,120.

* At Rock's Mine, Cornwall, an engine has worked day and night without intermission for 3½ years. At the East London Water-Works, a pair of engines, called "the twins," have worked 11 years with scarcely one hour's rest day or night.

sure, a pair of engines and a pair of air-pumps, each of half the requisite power, may be fixed at each station: should any thing cause one engine and pump to stop, the traffic would not be interrupted; the only delay would be the retardation of the train while passing over that section of pipe where only half the power was in action, and until the cause of the stoppage were removed the trains would be some five or six minutes more than usual performing the journey.

The next objection we have to meet is the interruption to the traffic from some derangement in the pipe. This comprehends, 1st, an accident to the pipe itself; and, 2nd, from the composition not being effectually sealed.

An accident to the pipe can only occur from breakage, and, unless designedly perpetrated, could never happen at all. But for the sake of argument we will suppose a pipe has been broken—no matter how; the time of removing it and replacing it with another would be considerably less than the time now necessary to clear off the fragments of a broken engine and train after a collision; and supposing a length of valve to require replacing, it could be done in less time than replacing a rail when torn up by an engine running off the line.

If, instead of one, there were one hundred places along the pipe where the heater had imperfectly performed its functions, the admission of atmospheric air through the composition in these places would

only reduce the column of mercury a few inches: no stoppage or interruption of the traffic could possibly occur from this cause, and by comparing the quantity of air pumped out each stroke of the pump, with the quantity that will leak in at each imperfectly sealed spot, any such erroneous idea will be removed. Perhaps on this head, an appeal to experience will be more satisfactory than any argument, however strong: in the whole of our workings, the column of mercury has never varied in height more than 2 inches on the same day; and as it requires eight times the number of minutes to destroy the vacuum in the pipe, when the engine is at rest, that it takes to raise it when in action, it follows that one-eighth only of the power (two horses) is all that is employed to overcome leakage. Perhaps the *necessity* of stopping the traffic of a line in the event of an accident until the damage is replaced or the obstacle cleared away, should be regarded upon all railways as a peculiar advantage: by this *necessity* all chance of "running into" is avoided, and where stationary power is employed the difficulties of communication which a locomotive line has to contend with are overcome. By means of an electric telegraph, every engine station along 100 miles of road may be communicated with in half a minute, and thus the traffic may be suspended and resumed at pleasure.

On examining the facts we have collected, it will be seen that the atmospheric system is grounded on sound principles, and free from many objec-

tions that the present railways have to contend with; and a very casual reference to these defects will prove the necessity of substituting an improved system to meet the wants of the public, when this means of travelling becomes fully developed and understood.

The general benefits that railway travelling has conferred, are admitted by all; their introduction has given a new stimulus to industry, and presented increased facilities for the merchant, manufacturer, and agriculturist, by bringing the remotest parts of the kingdom within a day's journey,—thus enabling goods and agricultural produce to be conveyed to distant towns, for which the previous mode of transport was unequal; indeed, the numerous advantages of railways have been fully appreciated by the public, who have not hesitated to embark immense sums of money to construct them between most of the principal towns.

In proportion as persons have acquired a knowledge of the commercial benefits that arise from this improved system of travelling, and have felt the advantages of it practically, their distaste for the old mode of conveyance has increased; and if railway communication were attainable at a cost at all approximating to that previously employed, it would very shortly become universal throughout the empire. But the general adoption of the railway system followed its introduction so speedily, that many roads were half finished before their expenses

could be ascertained; each town capable of raising sufficient capital to connect itself with the metropolis did so immediately,—more eager to be on a par with its neighbour, than considerate of the expense it was about to incur. Fortunately these increased facilities in many cases *created* a traffic which compensated for the unexpected outlay that was found necessary to form and work these roads; and as there is now so large a portion of capital sunk in this description of property, and a moral certainty that a greater number of railways will be made in the next ten years than have been made and partially completed in the last,* any invention tending to facilitate their formation, or to reduce their cost, is a matter of the greatest national and commercial importance: and if by such an invention the speed of travelling can be further increased, the danger of accidents diminished, and the expense of transporting goods reduced to as low a rate as by canals, the traffic, and, as a natural consequence, the remuneration to the proprietors, will be proportionably augmented.

Our object is to point out, that these results will follow the adoption of the atmospheric system of working, and we think it will be admitted that we have fully borne out and justified this idea, when we have taken a review of the nature of the power and

* In England alone, since 1831, upwards of 2000 miles of railway have been completed, or are in progress of completion.

the experience already obtained on the one hand, and of the drawbacks under which the present system labours on the other. We will first notice the principal defects in railways worked by locomotive power. These are the expenses consequent upon their formation and working, in addition to the impossibility of obtaining a speed beyond 25 miles an hour, without incurring a more than proportionate additional expense. For an engine that would draw 61·29 tons on a level at the rate of 25 miles an hour, would, if required to travel 30 miles an hour, only be able to draw 29·66 tons, or, for the additional 5 miles in speed, a loss of more than one-half in power. These evils arise from the following causes: (see Note, page 50.)

First, from the necessity of making the roads comparatively level, owing to the nature of the power employed. The whole power of the locomotive engine is not available to impel the *train*, because it has to drag itself and tender. Thus a great portion of its power is consumed even on a level; but that loss of power is greatly augmented when contending with the slightest ascent.

The extent of this defect will be more clearly apparent by an example:

Supposing a locomotive engine to possess a gross tractive force of 1700 lbs., and its weight, including tender, to be 20 tons, (this is the actual weight and tractive force of the best locomotive engines in general use when travelling at a mean rate of 20

miles per hour,) and as 14 lbs. per ton is required to attain this velocity on a level road, 280 lbs. will be consumed to impel the engine and tender, leaving 1420 lbs. available for the train. This, at 14 lbs. per ton, will draw 101 tons on a level road. We will now place the same train on an inclined plane rising 1 in 50. The power required to draw a ton at the same speed is then increased from 14 lbs. to 59 lbs., or nearly 4¼ times as much as on a level: therefore the engine and tender weighing 20 tons will consume 1180 lbs. instead of 280 lbs., and will leave but 520 lbs. available for the train, instead of 1420 lbs.; but as the train now needs 5959 lbs. to enable it to ascend, 11½ locomotives, each possessing a tractive force of 1700 lbs., together 19,550 lbs., will be required to produce that available force: we thus have an absolute waste of more than two-thirds of the power employed on an ascent of 1 in 50, while on a level it is less than one-sixth. By the same calculation it will be seen, that if the acclivity be slightly increased, the locomotive engine will not have sufficient power to draw itself and tender, even without the train.

Secondly, by the necessity of having great weight and strength of rails and foundation consequent on the employment of locomotive engines. These engines (exclusive of tender) weigh generally from 14 to 15 tons each; and, in addition to the rigidity of road required to sustain this weight passing over it on one carriage, the motion transferred to the

wheels by the engines alternately on each side, causes a continual displacement or forcing out of the rails.

The third, and perhaps the greatest evil, is the heavy expense attendant on working a railway by the ordinary method; and this item is rendered more excessive by the necessity of having a large number of extra engines in store, to keep an adequate supply in working order. By reference to the half-yearly accounts of the Liverpool and Manchester Railway, the annual expense for locomotive power and coke is found to be from £57,000 to £60,000 a year, nearly £2000 a mile per annum, on a traffic of about 1700 tons a day. This amount is exclusive of first cost and interest on the original stock.

The fourth evil is the large consumption of fuel in proportion to the power obtained, which arises, in part, from the great velocity in the movement of the pistons, preventing the steam from acting on them with full force; which causes a back pressure on the pistons, reducing their force in proportion to the velocity at which they move: the power of the engine is thus constantly diminished as the velocity of the train is increased. To so great an extent is the combined action of these defects felt, that when travelling at 20 miles per hour, the effective power of the engine is reduced to half that which would be obtained from the same quantity of steam generated, and fuel consumed, with a sta-

tionary engine. When travelling at 30 miles per hour it is reduced to less than one-fourth; and at a speed but little exceeding 45 miles, the power is so far destroyed that the engine will scarcely draw more than itself and tender. An additional waste of fuel, to an immense extent, is also occasioned by the loss of power (as already shown) on inclined planes. And, lastly, the chances of accident from collision, running off the rail, bursting of boilers;—effects, which have been too severely felt during the past six months.

From the foregoing remarks it will appear that the evils of the present system are entirely attributable to the use of locomotive power, and the remedy must be sought for in the employment of stationary power in its stead: the means by which this can be effected without diminishing the accommodation and advantages at present given to the public, are next to be considered; and it is confidently expected that in the following summary will be found, not only remedies for all existing evils, but also many important advantages, both in speed and safety, which cannot possibly be obtained by the above-named system.

On the Atmospheric System.

1st. The loss of power occasioned by the locomotive engines having to draw their own weight is entirely avoided, and steep hills may be ascended with no more additional power than that actually

due to the acclivity, as there is no weight except the train.

There is no other known power which can be applied to locomotion without carrying considerable weight and friction with it. The ill effects of locomotive engines have been already pointed out, and the same disadvantages exist in the application of ropes, which must be drawn along with the train, and become an increased incumbrance on inclined planes. The defects of ropes in other respects are too generally known to need comment.

2nd. The weight of the rails and chairs on the new system may be less by one-third than where locomotive engines are employed, as the carriages of the train will be too light to injure them. The annual charge of maintenance of way will, from the same cause, be reduced to a considerable extent.

3rd. The wear and tear of locomotive, compared with stationary engines, is as 18 to 1.

4th. By the new system the full power of the engines is always obtained; and on an incline the additional quantity of fuel consumed in ascending will be saved in descending, as the trains run down by their own gravity. The expense of fuel will be further decreased, as the expense of using coal is only half that of coke.

On the new system the velocity depends entirely upon the velocity with which the air is withdrawn from the pipe; therefore, by simply increasing the air-pump, any speed may be attained; and with a

fixed quantity of traffic per diem, no considerable increase in the fuel consumed or any other expense is incurred for improved speed, further than the small additional power required to overcome the increased atmospheric resistance. An actual saving in the first cost of a railway constructed for high velocities may be effected, because, by performing the journey in less time, a greater number of trains may be despatched each day, and their weight diminished; therefore the piston, having less to draw, may be smaller in diameter. The cost of the pipe (which forms the largest item in the first cost of this railway) will thus be reduced in nearly the same proportion as the speed is increased.

Besides these advantages, this system possesses others of still more importance to the public. *No collision between trains can take place*, for as the power cannot be applied to more than one piston at a time in the same section of pipe, the trains must ever be the length of a section apart from each other; and if from any cause a train should be stopped in the middle of a section, the train which follows it will be obliged to stop also at the entrance of the pipe, as there will be no power to propel it until the first train is out. It is also impossible for two trains to run in opposite directions on the same line, as the power is only applied at one end of each section. *A train cannot get off the rail*, as the leading carriage is firmly attached to the piston, which travels *in* the pipe *between* the rails, and the

luggage and carriages cannot be burnt, as no engines travel with the trains.

We now come to the comparative cost of the two systems.

1st. The necessity of having the railway comparatively level causes the present enormous outlay for earth-work, viaducts, and tunnelling, and increases the cost of land, not only by lengthening the line to save cutting and embankment, but by the quantity wasted on each side of the road wherever such work is required. Thus, if an embankment or cutting has to be made of 30 feet, at least 60 feet of land must be covered on each side of the railway in order to obtain sufficient slope, making a width of 120 feet, besides the road, except where they occur in very favourable ground. The comparative expense of this item between the two systems can be ascertained by referring to the average cost of forming a turnpike road and that of the principal railways now in operation.

Since it is not necessary to make detours to avoid steep gradients, the direction of the road in a straight line may be more nearly preserved.

LOCOMOTIVE SYSTEM.

	Per mile.
Taking five of the principal Railroads as the basis of our calculation, their average expense of formation has exceeded * . . .	£36,000
And the original stock of Locomotives . .	1,600
	£37,600

ATMOSPHERIC SYSTEM.

	Per mile.
The average expense of forming a turnpike road throughout England has been £3000 per mile, but for our road say . . .	£4,000
Allow extra for road-bridges . . .	2,000
Rails, chairs, sleepers, and laying down .	2,500
Main pipe and apparatus complete (on a scale for transporting 360 tons per hour, or 5000 tons per day of fourteen hours, on a road with gradients of 1 in 100) . . .	5,200
Fixed engines, air-pumps, and engine-houses	1,400
Travelling pistons	20
	£15,120
Saving per mile in forming and furnishing on the Atmospheric system . . .	22,480
	£37,600

Annual expenses of working per mile, when conveying *two thousand tons* per day. (This is beyond the average quantity conveyed on the Liverpool and Manchester Railroad):—

* Our calculations are founded on the reports of different companies whose railways are complete or in a forward state.

LOCOMOTIVE SYSTEM.

	Per mile.
5 per cent. interest on capital sunk, £37,600 .	£1,880
Maintenance of way	450
Locomotive department, including coke . .	1,800
	£4,130

ATMOSPHERIC SYSTEM.

	Per mile.
5 per cent. interest on capital sunk, viz. £15,120	£756
Maintenance of way, and attendance on mains	300
Wear and tear of fixed engines, 5 per cent. of cost	70
Coal 0·75 lb. per ton per mile, 214 tons, at 20*s*.	214
Wages to engine-men and stokers . .	60
Wages to train conductors . . .	26
Renewal of travelling apparatus and composition	50
Sundries	150
	£1,626
Annual saving per mile on the Atmospheric system	2,504
	£4,130

Total expenses per ton per mile on the Locomotive system 1·54*d*.
Ditto ditto ditto on the Atmospheric ditto 0·6*d*.

Exclusive of carriages and management, which may be taken as the same on both systems.

In the comparison which we have instituted between the locomotive and the atmospheric systems, we have not dwelt particularly on many important defects of the locomotive system, but have only

noticed them with a view to point out their existence, and to show that the very nature of the system we are advocating, prevents the possibility of their being found in it. We do not think, however, that we should do justice to ourselves if we were not to notice more fully some of the worst of these evils, with the view of ascertaining to what they are attributable, and what hope exists of remedying them. We have no wish, nor unfortunately have we any occasion, to exaggerate the dangers of steam travelling. Not a newspaper but teems with arguments the most cogent, the most appalling, in favour of a change of system. We may be told that these arguments have been listened to; that the attention of the Legislature has been called to the subject, and that consequently steps will be taken so as to entirely prevent the recurrence of the deplorable sacrifices of human life. We answer, that it is impossible. The fault is in the system; and no legislative enactments, however stringent, can remedy it. We have no need of assertion to prove this position. The Report of the Liverpool and Manchester Railway Directors, and adopted by the general meeting of railway proprietors at Birmingham, on the best means of preventing accidents on the lines, has just been published, and we desire no other arguments to support our views than the opinions put forth by these Directors, who must be admitted, from their great experience, to be competent judges of the question, and whose interest is

too deeply concerned to allow them to exaggerate the evils they comment upon. The following is the substance of their Report.

" In considering the subject of the various ac-
" cidents which have recently taken place on dif-
" ferent railways, and the different circumstances
" connected with each accident, it appears that they
" are attributable to one or more of the following
" causes:

" First. The want or insufficiency of signal lights,
" giving warning of danger.

" Second. Neglect on the part of engine-men of
" such signals when given, comprehending a cul-
" pable want of care and vigilance in not keeping
" a good look-out; and,

" Third. The difficulty of stopping a train when
" danger is perceived near at hand."

With respect to the first cause the Committee are of opinion, " that the printed rules and regula-
" tions of this Company, which have been brought
" under the consideration of many other companies,
" and, as your Committee believe, constitute the
" basis and tenor of their respective regulations,
" are, on the whole, well calculated to answer
" the purposes intended. One modification seems
" desirable, viz., that the red light or the red flag
" should, in all cases, and under all circumstances,
" be viewed as a warning against danger."

As to the second point; " the Committee can
" only recommend great care in the selection of

" active steady men in the first instance. Good " wages, and a considerate regard to their comforts " so long as they do their duty; accompanied by " the strictest discipline, and by uniformly putting " in force the provisions of Lord Seymour's Act in " cases of any neglect of duty or disobedience of " orders, hazarding the safety of life or property, " although no loss of either should take place."

" With respect to the third point under review, " the difficulty of promptly stopping trains when " danger is perceived, the most efficient means " hitherto employed are immediately to reverse the " engine, and put on the tender break. Great care " should be taken by the engineers that the reversing " gear is of the most improved construction, not " liable to get out of order, and which cannot fail " to act when the reversing lever is applied. " With regard to the numerous proposals of im- " provements and schemes for the prevention of " accidents by mechanical means, if that unceasing " vigilance which cannot be too strongly insisted " upon on the part of the engine-driver should " be at any time relaxed, those who have not been " long conversant with the practical working of a " railway can hardly be aware how many of them " have been long since, and under various forms, " already tried, and found to be attended with risks " and inconveniences more than compensating for " any supposed advantage."

The Committee strongly deprecate the idea of

relieving the engine-man from " the responsible " charge of his engine " by appointing a " conductor " of a higher standing and superior acquirements, " whose special business it should be to look out, " and under whose orders the engine-man should " act.

" By introducing another man on the engine you " have another pair of eyes to *look out;* but this " advantage, if it be one, might be more than coun- " tervailed by the divided authority and respon- " sibility which must inevitably take place.

" Jealousy, and disunion, it is to be feared, would " frequently arise. These would be destructive of " confidence in their own resources to the men " themselves, and fraught with danger to the whole " train. As to the necessity for superior acquire- " ments or professional skill, there is no evidence " of a single accident having occurred owing to the " want of these qualifications. The desiderata are " *constant vigilance* and *presence of mind* in emer- " gencies; and your Committee are of opinion that " no man, however professionally competent, ought " to be trusted with the charge of an engine till he " has served an apprenticeship to the business, and " has thus become familiar with the rapidity of the " locomotive engine and its consequent excitement, " *with its severe exposure to the weather*, with the " customs and practice of railway operations, and " with all the contingencies of locomotive transit " regarding police regulations, signals, &c."

Such are the only means recommended by the Liverpool and Manchester Railway Committee, with a view to get rid of the dangers attendant on this method of travelling; and we really believe that these gentlemen have suggested all that can be done; and if all railway accidents, or the greater number of them, were attributable to carelessness and neglect on the part of the engine-drivers, their suggestion would go far to remedy the evil. But here we contend they are greatly mistaken; the fault is in the system, not in the men. It is quite true that the evidence produced at many of the inquests puts beyond doubt the fact, that the necessary signals have on those occasions been made and must have been seen; yet no attention appears to have been paid, and the most disastrous consequences have been the inevitable result. But does it follow that this inattention on the part of the conductor has been the result of *wilful* neglect? Can it be for a moment believed that any man would thus rush headlong into danger, to the almost certain destruction of his own life, and the imminent hazard of those committed to his care? Common sense repudiates the thought. Nothing short of madness could lead to such gross acts of crime and folly. Let us next consider the circumstances under which these accidents occur, and it will be readily seen that they may be accounted for much more satisfactorily. Many alternatives must be rejected before having recourse to the insanity of the engine-drivers for

an explanation. It will be seen that the question to be discussed is not, have the conductors the *will* to avert these calamities, but have they the POWER?—not whether we are to consider them as suicidal maniacs, but as the slaughtered victims of a murderous system. Let the impartial reader judge.

Suppose our engine director fully understands the construction and management of his engine; suppose we can answer for his discretion, that he never gets intoxicated, never gets fatigued, never falls asleep while on duty, never leaves his engine while on the line, never "sits down on the seat;"* suppose him uninfluenced by the "excitement" of rapid travelling,"† or by the "severe exposure to the weather."‡ Let us suppose that he can readily attend to the working of his engine, and yet keep a good look-out ahead; that he retains his vision perfect under all circumstances; that it is unimpaired by moving rapidly through the air, and is not affected by the clouds of ashes from the chimney. Let us suppose, moreover, that the atmosphere is always clear, that fogs never occur, or that they never prevent him distinguishing the colour of a flag or lamp; and, lastly, let us suppose that no curves exist on the line, and that he is

* One of the charges made against the unfortunate Simpson on the inquest.

† Vide Report. ‡ Ibid.

consequently enabled to see the signal half a mile ahead of him. Now what is the time, under all these favourable circumstances, allowed to the conductor by the usual speed, to shut off the steam, give the signal for the breaks to be applied, or, if necessary, reverse his engine? *One minute!* But in addition to the above absurd suppositions, we have presumed that the accident by which a train has been stopped has taken place at a station, and that the danger is consequently known; we have presumed that, knowing this danger, the Company's servants have hoisted the red flag or lamp. But trains much more frequently break down between stations, where they cannot be expected to be provided with signals: we frequently hear of trains getting on the wrong line and meeting each other. How are they in such cases to be apprised of their danger? If they are enabled to see each other at half a mile, and recognise their dangerous position, yet but *half a minute* must elapse before they come into collision if unchecked? Is it possible that this short space of time can be sufficient for the two engine-drivers to think, act, and give their directions for others to act? And if so, can we be certain that the machinery by which the engines are stopped is in proper order to obey these actions of its director? It may be of "the most approved construction," and may have been perfect on commencing the journey; but does it follow that it is so

at this particular moment? It is well known that the cost of repairing locomotive engines is about 50 per cent. of the first cost;—is the reversing gear, are the valves, breaks, the machinery, in short, now required to act, never among these expensive repairs? Or are we to believe that the accidents by which they are deranged always occur at the stations? No answer is required to these questions. No one, we think, will presume to assert that these parts are excepted from the fatalities which occur to the rest, or that they take place while at rest. The precautions strongly insisted upon in the Report relative to this machinery prove that they have been called for. And now we would ask, are we justified in attributing these melancholy occurrences to the folly of the engine-driver? Is it not sufficient to see his mutilated corpse stretched before us, but we must accuse him of *felo de se*, and refuse his remains a Christian burial, when an accident to the machinery (of the occurrence of which the Report indirectly admits the possibility) would at once excuse him? Charity, pity, all the better feelings of humanity, answer in the affirmative.

It will be readily seen that the suppositions we have made in order to give every possible advantage to this system are absurd, for we have assumed humanity to be perfect, materials indestructible, the atmosphere invariable, curved lines straight; yet this is not sufficient: we must still presume that

actions require no time for their performance, and that matter is deprived of its *vis inertiæ!* Had we drawn an inference from the facts that sad experience has afforded us to judge from, we should have concluded the danger to be entirely referable to the use of locomotives, huge masses moving at a great and *varying* velocity, and over which the conductor has comparatively no control. To render railway travelling safe, (a method of travelling now so essential to the commercial prosperity of this country,) we must begin by rejecting the locomotive, and substituting in its stead stationary power.

If we have shown, as we hope we have, dispassionately and fairly, that so large a balance of safety is due to the atmospheric system, the large saving of human life and suffering that would result from its adoption ought to be one of its best advocates for public patronage; and in the same proportion that it restored public confidence and appetite for railway travelling, would it benefit the Directors and Proprietors. Every fatal accident, on whichever railway it has occurred, has been followed by a sensible reduction in the traffic; and this can be a matter of no surprise, when it is recollected that the present traffic possessed by all railways was actually *formed* by the increased facilities and inducements they held out to travellers over turnpike roads: remove these facilities, and the increased traffic will vanish. No railroad in existence could

pay its expenses carrying only such passengers as are actually *obliged* to travel, and therefore the best policy of Railway Directors is to induce the public to use their lines by affording them the fullest and best accommodation as regards safety, speed, cheap fares, and agreeable travelling. That railway which provides best for the wants and wishes of the public will, and very properly so, become the most patronised; and it is scarcely too much to assert that a very large portion of business will spring up and locate itself along such lines, while others which may at present possess a large traffic will lose what they found to their hand, if, neglecting this course, they lull themselves into the mistaken notion that the monopoly they possess, not the convenience they afford, will guarantee them an equal amount of business.

The first grand object in railway undertakings is to render them a perfectly secure mode of transit —a conveyance by which the most timid may travel without hesitation, without a thought of fear, and of course without an example of ill, arising from the badness of their workings, to refer to: these great works, destined as they are to effect much good to all classes of society, will never be, nor indeed deserve to be, looked upon as a permanent benefit until they have arrived at this point. Precisely as a country flourishes under a well regulated system of police and justice, where the liberty and right of the subject are respected, so will railways flourish

as human life in their keeping becomes secure. The high roads of England became more travelled over as the robbers that infested them fell into the hands of justice; and it is a matter of small importance to a person contemplating a journey whether he have to fear falling a prey to the assassin's knife, or losing his life from the collision of two railway trains. The possibility of either would equally prevent the timid from travelling, and the courageous from travelling more than necessity required.

To render the railway system perfectly secure is, then, the first object, and to this end should those who have its prosperity at heart look well. Humanity dictates it, and interest prompts it; and what greater inducements, we would ask, need be urged?

Perhaps the next point, after having arrived at that degree of security required to satisfy the public, is to obtain that system of working which is the most economical. A large portion of the British commercial public have, with that enterprise which characterizes all their actions, embarked large sums of money in establishing railway communications between most of the principal towns in the kingdom. They saw the advantages that were certain to result from such an improved communication, but they did not know, indeed it would have been too much to have expected from them, the expense of making and maintaining this communication. They only knew what their engineers told them.

Their engineers' estimates in most cases were considerably less than was found necessary for the work, and this, added to the increased annual expense of working (above that originally contemplated when most of the present lines were projected), has placed these undertakings in a very questionable light as commercial speculations and permanent investments. If we show this to be the present position of most railways, which we intend doing by reference to their own accounts, we wish it to be understood that we do not from this circumstance draw a conclusion that they cannot be made a lucrative investment. On the contrary, we are of opinion that they can: we think it has been clearly shown that all their difficulties have arisen and are perpetuated by the use of an improper system of working. So long as the locomotive system is adhered to, a strict economy may in a small degree lessen the expenses, but no material improvement can be hoped or obtained. To strike at the root of the evil, the system must be abolished; any thing short of this will not be productive of benefits on a sufficiently extensive scale to enable railways to maintain their present position, and yield a return for the millions they have cost. A better instance of this fact can scarcely be needed than an inspection of the receipts and expenditure of those railways already in operation. From the official weekly returns in the "Railway Times," we perceive *seventeen* railways are in operation the

whole of their length, and out of the whole number only *three* are earning sufficient to pay their subscribers more than common interest for their money. Of the remaining fourteen, *six* are not taking as much for their *gross* receipts as the interest of their capital embarked, *independent* of working expenses; and the receipts on the remaining *eight*, after deducting the working expenses, do not leave £5 per cent. dividend for their subscribers.

Fifty millions sterling have been embarked in railway speculations, and seventeen lines have come into full working activity, of which number only *three* can show a return beyond common interest to the subscribers: it well behoves capitalists to ascertain the cause of their disappointments, and to seek to recover some of the golden harvests they were led to expect, and which have melted away before their eyes like ice in the rays of the sun. Any thing short of perfect indifference to their own interest will force on them the conclusion that they must investigate and judge for themselves; that they must no longer shut out the idea of improving, and listen only to the counsel and advice of those at present in their confidence, whose interests are served by maintaining things as they now are, and by clinging to preconceptions and prejudices as part and parcel of their existence. When looking over the half-yearly accounts of a railway worked by locomotive power, common sense and observation

cannot fail to lead to the conclusion, that a very large portion of what *would be profits* is absorbed by the nature of the power applied; but although a cursory notice of the accounts would prompt this conclusion, few would imagine, without giving the matter very close attention, how great this portion is. Some idea of it may be drawn from the following facts. Each train on railways is drawn by an engine, the average weight of which is 20 tons; therefore 20 tons carried with each train is perfectly useless. On the London and Birmingham Railway the lowest charge for goods is £2 per ton for the whole 112 miles. Supposing, for the sake of argument, the expense of maintaining and working the locomotive department to remain *unaltered*, but the engines to weigh *nothing*; it is clear that the Company would be able to transport 20 tons more with each train for the same cost, or fifteen tons of profitable merchandise, after deducting one-fourth for the waggons, which at £2 per ton would add to their revenue £30 per journey, or, with their present number of trains, (12 each way daily)—£306,000 a year. No doubt this fact will take many railway proprietors by surprise, who by a natural course of reasoning will immediately seek to discover by what means so large an amount, at present wasted, can be made to find its way into their pockets. The means are obvious: the waste is occasioned by transporting useless weight; remove the useless weight, and the objection ceases of itself. Before

the introduction of the atmospheric system, it was hopeless, by any known mechanical means, to effect this; every previous application of power carried considerable useless weight with it. The atmospheric is entirely free from this objection; and it was mainly from a knowledge of the benefits that must result from this source that we have laboured so incessantly (and happily with such success) to mature, and bring it before the public, for their consideration and approbation.

Such would be the effect of dismissing only the *useless weight;* but add to this the other advantage possessed by the atmospheric system, and the London and Birmingham Railway (notwithstanding its present large capital sunk) would be enabled *to carry passengers at 5s. each, and goods at 6s. 3d. per ton, the whole* 112 *miles, and share the same dividend as now.*

The calculations from which this statement is adduced are shown as follows; viz.*

	Per day.	Per year.
2500 persons @ 5*s.* each . . .	£ 625	
5930 tons merchandise @ 6*s.* 3*d.* per ton	1853	
	£2478	
	——	£805,350

* This estimate of traffic is of course much greater than at present exists on the line, but considerably *less* than the reduced prices would produce: it is scarcely necessary to add, that at these rates *any* extent of traffic could be obtained in coals and iron alone, as it is less than a sea-borne freight from the north.

	Per day.	Per year.
Brought forward		£805,350
Expenses, viz.		
Coals, 38 stations × 500 lbs. per hour × 16 hours per day = 6867 tons per year @ 10*s.* per ton	£3,434	
76 engine-drivers @ £100 per year	£7,600	
76 stokers @ £50 per year . .	3,800	
Repairs to engines, oil and tallow, @ £70 each × 38 . . .	2,660	
	14,060	
Renewal of travelling apparatus, composition, charcoal, &c. £100 per mile × 112	11,200	
Maintenance of way and attendance to main £300 per mile	33,600	
Police, coaching, waggons, &c. (as on locomotive lines)	80,604	
General charges (as on locomotive lines) .	15,400	
Parish rates (as on locomotive lines) .	14,400	
Add 5 per cent. interest on £1,500,000, the total amount required to furnish the atmospheric apparatus on a scale for transporting 9600 tons per day . . .	75,000	
		247,698
	Balance	£557,652
By reference to the last General Meeting of the London and Birmingham Railway Company, (see "Railway Times," 13th February, 1841,) the present receipts average per year	£810,000	
And the present expenses . . .	260,000	
	Balance	£550,000

The present charges are—

For passengers (average) . . 25*s.* each.

Lowest charge for merchandise . 40*s.* per ton.

We have already shown the expense of formation in railways to be greatly influenced by a portion of the power employed being unavailable, and that the road is levelled as a convenience for the propelling power, not the traffic conveyed. We have also shown that the destruction to the road is attributable to the weight and shocks of the engines, not of the trains; that the enormous expense of locomotive power and coke arises from the bad application of power and the artificial means employed to work engines at an unnatural speed. In other words, all the expenses have been traced home to the use of locomotive engines, which have, from the opening of railways for passenger traffic to the present day, been a source of continual annoyance and vexation; breakage after breakage has occurred, and been succeeded by increasing the weight and power of the machines; this in turn has led to the necessity of increasing the strength and stability of the rails and foundations on which they travel, and increasing the strength of the passenger-carriages, to resist any shocks they may occasionally receive from their ponderous neighbour;—until we have arrived at this conclusion, that on an iron railroad, where the surface is by comparison smooth and the track marked out, a carriage to convey eighteen passengers must weigh about 3 tons, while over a rough paved road an omnibus weighing only 1 ton will perform the same amount of duty. Here are facts which must at once convince every one that there are in the present

system, radical defects to be weeded out: if no remedy were suggested, it might be difficult for Railway Companies to determine how to extricate themselves from their present position; but under existing circumstances their position is by no means a difficult one. The Atmospheric Railway has been tested by actual operation at the entire expense of the inventors and their friends. The public have not been asked to support it, or even encourage it, until it has been clearly proved beyond all doubt to merit confidence from its general usefulness. It has claims to notice both in a national and commercial point of view; for while it will afford the means of railway communication to second and third-rate towns by the small outlay necessary for the formation and working, it will enable the proprietors of railway enterprises already established or in course of formation, to realize that return for their capital which they so richly deserve, and which under the present system they so hopelessly look for.

THE atmospheric principle for propelling carriages on a railway being fully proved, we shall now describe its applicability to Turnpike Roads for the conveyance of merchandise, farming stock, &c., &c.

By a reduction of velocity, say from 35 miles per hour, the ordinary safe speed on an Atmospheric Railway, to 12 miles per hour, this system of locomotion can be applied to any mail-coach road in Great Britain. The expense of working on this plan has already been shown to be so trifling that goods may be conveyed 100 miles for 6*s*. 3*d*. per ton, and passengers the same distance for 5*s*. each. This rate will pay all tolls to the turnpike road, and leave a handsome dividend for the outlay of capital. All the expenses before cited being equally applicable to turnpike roads, and having been deduced from what has been already done, the whole would be taken by contract at the prices herein stated; therefore, there can be no mistake on that head. The expenses are thus strongly insisted on because the cheapness of conveyance is so far beyond what could be contemplated, that if it were less confidently stated it might by some be thought an exaggeration.

In converting a turnpike road into a double line of Atmospheric Railway, the Macadamised part of

the road is left entire for ordinary traffic, and the railway is crossed without bridges at the different partings. The velocity being reduced to 12 miles per hour, sharp curves will be turned with ease; all dangers will be avoided, as the carriages can be stopped in an instant in case of carts crossing the line, or any other obstruction, or to take up passengers and parcels; they will pass along the main street of a country town without pipe, and be in every respect as subservient to the conductor as a common stage coach to the driver.

Independently of the ample remuneration to be derived by those who embark their capital in this plan, of what vast importance will it be for a commercial country like this to have the produce of one part conveyed to another at so slight an expense and so rapid a rate! The live stock will no longer be driven. The poorest traveller will find it an extravagance to walk. Farming produce will be conveyed to a market-town so quickly and cheaply that it will be as fresh and almost as cheap on reaching its place of destination, as in the producing country.

Note.—Gross load in tons which a locomotive engine, capable of evaporating sixty cubic feet of water per hour, will drag, exclusive of the tender, at the under-mentioned rates of speed, on different inclinations of planes.

Inclination of plane.	10 miles an hour.	12½ miles an hour.	15 miles an hour.	17½ miles an hour.	20 miles an hour.	22½ miles an hour.	25 miles an hour.	27½ miles an hour.	30 miles an hour.
	tons.	tons.	tons.	tons.	tons.	tons.	tons.	tons.	tons.
level.	346·	251·10	187·84	142·64	108·75	82·38	61·29	44·04	29·66
1 in 4480	325·72	236·09	176·35	133·66	101·65	76·75	56·83	40·54	26·95
1 in 2240	307·58	222·67	166·06	125·62	95·30	71·71	52·84	37·40	24·54
1 in 1120	276·47	199·65	148·44	111·85	84·41	63·07	45·99	32·03	20·39
1 in 1000	269·87	199·76	144·70	108·93	82·11	61·24	44·54	30·89	19·51
1 in 900.	264·59	190·85	141·70	106·58	80·25	59·77	43·38	29·98	18·80
1 in 800.	255·56	184·17	136·59	102·5	77·09	57·25	41·40	28·42	17·60
1 in 700.	246·17	177·22	131·27	98·43	73·81	54·65	39·33	26·79	16·35
1 in 600.	234·68	168·72	124·75	93·34	69·78	51·46	36·80	24·81	14·82
1 in 500.	220·02	157·87	116·45	86·85	64·65	47·38	33·58	22·28	12·86
1 in 400.	201·04	143·82	105·69	78·44	58·01	42·11	29·40	19·	13·33
1 in 300.	175·39	124·85	91·16	67·09	49·03	34·99	23·76	14·57	6·91
1 in 200.	138·48	97·54	70·24	50·74	36·12	24·74	15·64	8·20	1·99
1 in 100.	84·07	55·30	37·89	25·46	16·14	8·88	3·09	—	—

See Wood on Railroads, 2nd edition.

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